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# Endodontic Irrigants

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## Introduction

Evidence shows that if the three basic principles of the "endodontic triad" are followed, the end result will be successful endodontic treatment. These principles are (a) thorough debridement of the root canal, (b) sterilization of the root canal, and (c) complete obturation of the root canal.[1] In support of accomplishing these objectives, it is essential to use an irrigant or combinations of irrigants during the chemical & mechanical preparation of the root canal system. Mechanical preparation is required to enlarge the canal allowing the irrigant and subsequent obturation material to extend to the apical portion of the canal. The use of irrigants for the chemical preparation allows for the removal of pulpal organic material, inorganic dentinal debris, and microorganisms from the root canal system. This report reviews the rationale for the use of endodontic irrigants and gives guidelines and updates regarding the use of various endodontic irrigants.

## Desired Irrigant Properties

Primary root canal infections are composed of polymicrobial biofilms, typically dominated by obligate anaerobic bacteria.[2] Obligate anaerobes are easily eradicated during root canal treatment. However, facultative bacteria such as, Enterococci, are more likely to survive chemo-mechanical instrumentation and root canal medication due to their ability to survive with or without oxygen in the environment.[3] Irrigants should have a broad antimicrobial spectrum and high efficacy against aerobic and facultative microorganisms organized in biofilms. They should have the ability to inactivate endotoxin, dissolve necrotic pulp tissue and prevent the formation of a smear layer during instrumentation or dissolve it once it has formed. Root canal irrigants should be nontoxic, noncaustic and nonallergenic to periodontal tissues.[4] Common endodontic irrigants in use today include sodium hypochlorite (NaOCl), ethylene-diamine-tetraacetic-acid (EDTA), chlorhexidine gluconate (CHX), MTAD (citric acid (chelator) + Tween-80 (detergent) + doxycycline (tetracycline isomer)), and isotonic saline.

## Debridement &Tissue Dissolving

NaOCl is very effective when used for tissue removal. As the primary irrigant, various concentrations of NaOCl were found to be significantly more effective at dissolving necrotic tissue when compared to normal saline and 3% $H_2O_2$.[5] CHX has been shown to be ineffective at dissolving tissue[6]; making it undesirable as a sole irrigant.

## Antimicrobial Effects

In addition to dissolving tissue, NaOCl is also an effective antimicrobial irrigant. NaOCl forms hypochlorous acid when in contact with organic debris. Hypochlorous acid oxidizes the sulfhydryl groups of bacterial enzymes; disrupting their metabolism.[7] CHX is a hydrophobic, lipophilic bis-guanide that interacts with the bacterial phospholipids and lipopolysaccharides in the cell membrane. This disrupts the osmotic balance across the cell wall causing cell lysis.[8] In a study by Vianna et al., 2.5% NaOCl was found to be more effective at reducing bacterial counts in necrotic teeth when compared to 2% CHX.[9] When evaluating biofilm removal, Clegg et al. found both 3% and 6% NaOCl to be more effective than 2% CHX and BioPure MTAD in the apical 1/3 of the canal in necrotic teeth.[10] In addition to bacteria; yeast, such as *C. albicans,* has been found in infected root canals.[11] Both 6% NaOCl and 2% CHX were more effective in antifungal activity than BioPure MTAD or 17% EDTA when used as a final irrigant.[12]

## Canal Lubrication during Rotary Instrumentation

In addition to other favorable properties, a study by Boessler et al. determined that keeping the root canal filled with 1% NaOCl lubricated the canal resulting in a reduction in torque and decreased forces on rotary instruments. [13] This study determined that aqueous lubricants significantly reduced all outcome variables compared to dry conditions. The other irrigants discussed in this clinical update may also provide the same results, however they were not included in the above research.

## Chelators (smear layer removal)

When instrumentation of the root canal is complete, if removal of the smear layer is desired, an effective way is to irrigate the canal using 1 ml of 17% EDTA for 1 minute followed by 3 ml of 5.25% NaOCl.[14] For a more detailed update on smear layer removal, please refer to the 2009 Clinical Update, Vol. 31, No. 6.

## Substantivity (sustained antimicrobial activity)

A unique benefit of CHX is its substantive properties--sustained antimicrobial activity. Weber et al. reported 2% CHX had significantly more substantive properties than 5.25% NaOCl. 2% CHX was reported to have antimicrobial effectiveness on the surface of treated dentin for at least 7 days[15] while other studies have reported this up to 12 weeks.[16] However, when NaOCl and CHX are used together, research has shown a precipitate (para-chloroanaline) forms. This precipitate has been known to be toxic in humans. To prevent this precipitate formation, it is recommended to irrigate the canal with either water or EDTA and then dry with paper points to remove any residual NaOCl prior to irrigating with 2% CHX.[17]

## Irrigant Delivery

Complete instrumentation of the entire root canal system may not be possible due to anatomical irregularities of the canal. Being able to remove bacteria and other debris becomes especially important in the apical third of the root canal where most canal irregularities exist.[18] Sedgley found that in order to remove bacteria from the apical third of the canal the irrigation needle must be within 1 mm of working length.[19] When irrigating potentially irritating substances within 1 mm of working length, safety concerns become important. To reduce the risk of irrigants being expressed into the periapical tissues, irrigation tips should be side vented and possess a

blunt tip. Kahn et al. determined side vented needles in gauges 25, 28, and 30 were highly effective in removing dye solution from simulated canals prepared to MAF sizes 20, 25, 30 and 35 using a .02 taper K-file. The expression of fluid through the lumen created turbulence around and beyond the end of the tip allowing for maximum penetration of the irrigant into the root canal system.[20] Using a standard syringe needle can increase the risk of expressing caustic irrigants into the periapical tissues.[21]

**Gutta Percha & Endodontic File Asepsis**

To ensure asepsis with gutta percha in root canal therapy, the cones should be thoroughly disinfected before obturation. Research by Gomes et al. found only full strength NaOCl, with a contact time of 1 min, to be effective in killing bacterial spores on gutta percha cones when compared with dilute concentrations of NaOCl and varying concentrations of CHX.[22] This is in contrast to research evaluating asepsis of endodontic files with common endodontic irrigants. Gnau et al. determined that endodontic files taken directly from the manufacturers' packages are not sterile. Immersion of endodontic files in 6% NaOCl for 5 min was not sufficient to completely disinfect the files.[23] Endodontic files should not be used in patient care until they have been sterilized via steam autoclave.

**Conclusion**

At this time, there is no step-by-step methodology for irrigant use in the endodontic literature. Due to the tissue dissolving and antimicrobial properties, sodium hypochlorite is the irrigant of choice in the majority of nonsurgical endodontic treatments. The information presented here is based upon the current literature with the goal of optimizing chemical debridement and disinfection of the root canal system prior to obturation.

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